March 11th, *Mira* had decreased somewhat, and on March 14th, though of fifth-magnitude, it was scarcely discernible without magnifying power; and further observations of the interesting process of decline will have little value, owing to the increase of atmospheric disadvantages.

SAN FRANCISCO, March 19, 1896.

PERSONAL EQUATION.

BY R. H. TUCKER.

[Abstract].

The effect of errors due to personal equation upon the determination of star places is, in general, included in two classes:

In one, the effect is eliminated. In the other, the error can actually be determined by observations similar to those affected, and the proper correction can be applied.

If the personal equation in transits remains constant, for the same conditions, the effect upon the observation of the stars from which the clock correction is obtained is the same as that for the stars whose Right Ascension is to be determined. While there may be variation in the amount of error, and investigations of the personal equation for the same observer at different epochs have actually given, in some cases, discordant values, these variations must, in general, be included with the accidental errors of observation. The constant or systematic error is eliminated.

If the error has a variation depending upon the magnitude, this can be investigated by the use of screens for some of the observations of bright stars; the results for stars thus reduced in magnitude being compared with corresponding observations made with full brightness.

The effect of the direction of motion can be observed upon stars at the zenith, reversing the position of the observer, as is done in the observations for bisection error, described later.

The effect due to the rate of motion is harder to deal with, and cannot be obtained directly from the observations. The results, however, when compared with the Ephemeris Right Ascensions of fundamental stars, at various distances from the

Pole, will indicate the amount of this variation, accepting the system of Right Ascensions as standard.

For the Declinations, the personal equation in reading the graduated circle is evidently differential, whether the Declinations are made to depend upon observed zenith distances or upon observations of fundamental stars.

In the former case, the error in observing the coincidence of the Declination wire, over the nadir, could be found by taking nadirs facing north and south alternately. But, from the manner in which this coincidence is usually obtained, by placing the wire alternately on both sides of its image, there is not much likelihood of there being a serious amount of personal equation.

If, also, circumpolar stars are observed at both culminations, to give the value of the latitude to be used in determinations of star places for the same epoch, this error is eliminated.

The bisection error is a form of personal equation that it is important to consider. If there is a tendency to place the wire too high or too low, or in case a pair of threads is used to place the star above or below the center of the pair, every observed zenith distance would be affected.

If the determinations are strictly differential, and the declinations are made to depend upon those of stars near, the effect is eliminated.

It would be doubled for determinations of stars on one side of the zenith, depending upon fundamental stars on the other side, and consequently doubled for determinations of south stars, depending upon a latitude from circumpolars at both culminations. The effect would, however, be eliminated from Declinations observed at both culminations.

As one conclusion from these relations, it is obvious that to free a set of south stars from this form of personal equation, which may be classed as a systematic error of observation, it would be best to use stars south of the zenith as fundamental. The circumpolar stars would be freed from its effect, by taking the mean of determinations at both culminations.

There would remain a zone of stars between the zenith and he limit at which observations below Pole can be made. For these stars it would be necessary to know the bisection error, and to correct for it.

The error is indicated by observations of the same star, above and below Pole; but these are generally made with an interval of

six months, and, as there is a method of obtaining this correction by observation of zenith stars, it is advisable to use both means.

To give this method in its simplest form: If two stars, culminating at the zenith are observed, one with the face north and the other with the face south, the effect of bisection error is doubled for a determination of the latitude from each. If, on another night, the same pair of stars are observed, each in the contrary position for the observer, the combination of the results of the two nights gives double the bisection error, free from any error in either star's Declination; and all systematic errors of observation other than that sought for are eliminated.

This process should be often repeated, that accidental errors of observation may have as little effect as possible upon the final result.

Repetition at intervals is useful, in order to check any variation of habit. For the present series of observations with the meridian-circle there have been made three sets of determinations, to be followed by others before the completion of the work, in order that the entire series may be represented. The first set consisted of a pair of stars on each of sixteen nights, four pairs being used. These were included in the regular observing programmes. The later sets have been made on special nights, with five or six pairs each night.

The transits, observed at the same time, should exhibit a difference, amounting to double the error due to direction of motion. While these observations are reduced, for the greater part, the combination of results will not be made until the close of the work, lest the knowledge of what error may be indicated should have some slight prejudice upon current observing.